To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

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April 1st, 2010
Renesas Electronics Corporation

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Notice

HA1630S01/02/03 Series

Ultra-Small Low Voltage Operation CMOS Single Operational Amplifier

REJ03D0798-0100
Rev.1.00
Mar 10, 2006

Description

The HA1630S01/02/03 are single CMOS Operational Amplifiers realizing low voltage operation, low input offset voltage and low supply current. In addition to a low operating voltage from 1.8V, these device output can achieve full swing output voltage capability extending to either supply. Available in an ultra-small CMPAK-5 package that occupies only 1/8 the area of the SOP-8 package.

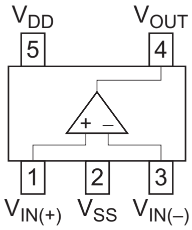
Features

- Low power and single supply operation — V_{DD} = 1.8 to 5.5 V
- Low input offset voltage — V_{IO} = 4.0 mV Max
- Low supply current — I_{DD} = 15 µA Typ (HA1630S01)
  I_{DD} = 50 µA Typ (HA1630S02)
  I_{DD} = 100 µA Typ (HA1630S03)
- Maximum output voltage — V_{OH} = 2.9 V Min (at V_{DD} = 3.0 V)
- Low input bias current — I_{IB} = 1 pA Typ

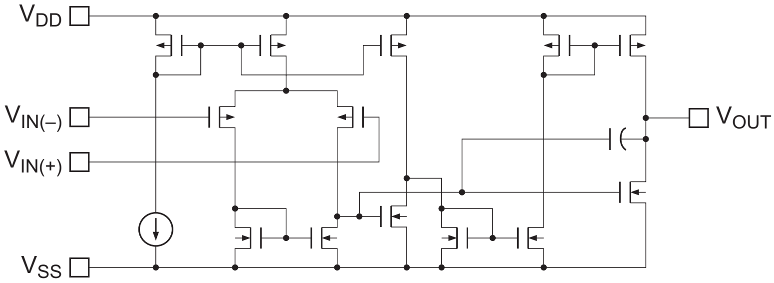
Ordering Information

Type No.	Package Name	Package Code
HA1630S01CM	CMPAK-5	PTSP0005ZC-A
HA1630S01LP	MPAK-5	PLSP0005ZB-A
HA1630S02CM	CMPAK-5	PTSP0005ZC-A
HA1630S02LP	MPAK-5	PLSP0005ZB-A
HA1630S03CM	CMPAK-5	PTSP0005ZC-A
HA1630S03LP	MPAK-5	PLSP0005ZB-A

Pin Arrangement



Equivalent Circuit



Absolute Maximum Ratings

(Ta = 25°C)

Items	Symbol	Ratings	Unit	Note
Supply voltage	V_{DD}	7	V	
Differential input voltage	$V_{IN(diff)}$	$-V_{DD}$ to $+V_{DD}$	V	
Input voltage	V_{IN}	–0.3 to $+V_{DD}$	V	1
Power dissipation	P_T	200	mW	
Operating temp. Range	Topr	–40 to +85	°C	
Storage temp. Range	Tstg	–55 to +125	°C	

Note: 1. Do not apply Input Voltage exceeding V_{DD} or 7 V.

Electrical Characteristics

(V_{DD} = 3.0 V, Ta = 25°C)

Items	Symbol	Min	Typ	Max	Unit	Test Condition
Input offset voltage	V_{IO}	—	—	4.0	mV	Vin = 1.5 V
Input offset current	I_{IO}	—	(1.0)	—	pA	Vin = 1.5 V
Input bias current	I_{IB}	—	(1.0)	—	pA	Vin = 1.5 V
Output high voltage	V_{OH}	2.9	—	—	V	R_L = 1 MΩ
Output source current	$I_{O\ SOURCE}$	6	12	—	µA	V_{OH} = 2.5 V (HA1630S01)
		25	50	—		V_{OH} = 2.5 V (HA1630S02)
		50	100	—		V_{OH} = 2.5 V (HA1630S03)
Output low voltage	V_{OL}	—	—	0.1	V	R_L = 1 MΩ
Output sink current	$I_{O\ SINK}$	—	(0.8)	—	mA	V_{OL} = 0.5 V (HA1630S01)
		—	(1.0)	—		V_{OL} = 0.5 V (HA1630S02)
		—	(1.2)	—		V_{OL} = 0.5 V (HA1630S03)
Common mode input voltage range	V_{CM}	–0.1 to 2.1	—	—	V	
Slew rate	SR	—	(0.125)	—	V/µs	C_L = 20 pF (HA1630S01)
		—	(0.50)	—		C_L = 20 pF (HA1630S02)
		—	(1.00)	—		C_L = 20 pF (HA1630S03)
Voltage gain	A_V	60	100	—	dB	
Gain bandwidth product	BW	—	(200)	—	kHz	C_L = 20 pF (HA1630S01)
		—	(680)	—		C_L = 20 pF (HA1630S02)
		—	(1200)	—		C_L = 20 pF (HA1630S03)
Power supply rejection ratio	PSRR	60	80	—	dB	
Common mode rejection ratio	CMRR	60	80	—	dB	
Supply current	I_{DD}	—	15	30	µA	$R_L = \infty$ (HA1630S01)
		—	50	100		$R_L = \infty$ (HA1630S02)
		—	100	200		$R_L = \infty$ (HA1630S03)

Note: 1. ( ) : Design specification

Table of Graphs

Electrical Characteristics			HA1630S01 Figure	HA1630S02 Figure	HA1630S03 Figure	Test Circuit
Supply current	I_{DD}	vs Supply voltage	1-1	2-1	3-1	2
		vs Ambient temperature	1-2	2-2	3-2	
Output high voltage	V_{OH}	vs Output source current	1-3	2-3	3-3	4
		vs Supply voltage	1-4	2-4	3-4	
Output source current	$I_{O\ SOURCE}$	vs Ambient temperature	1-5	2-5	3-5	6
Output low voltage	V_{OL}	vs Output sink current	1-6	2-6	3-6	5
Output sink current	$I_{O\ SINK}$	vs Ambient temperature	1-7	2-7	3-7	6
Input offset voltage	V_{IO}	Distribution	1-8	2-8	3-8	1
		vs Supply voltage	1-9	2-9	3-9	
		vs Ambient temperature	1-10	2-10	3-10	
Common mode input voltage range	V_{CM}	vs Ambient temperature	1-11	2-11	3-11	7
Power supply rejection ratio	PSRR	vs Frequency	1-12	2-12	3-12	1
Common mode rejection ratio	CMRR	vs Frequency	1-13	2-13	3-13	7
Voltage gain & phase angle	A_V	vs Frequency	1-14	2-14	3-14	10
Input bias current	I_{IB}	vs Ambient temperature	1-15	2-15	3-15	3
		vs Input voltage	1-16	2-16	3-16	
Slew Rate (rising)	SRr	vs Ambient temperature	1-17	2-17	3-17	9
Slew Rate (falling)	SRf	vs Ambient temperature	1-18	2-18	3-18	
Slew rate		Large signal transient response	1-19	2-19	3-19	
		Small signal transient response	1-20	2-20	3-20	
Total harmonic distortion + noise	(0 dB)	vs. Output voltage p-p	—	2-21	3-21	8
	(40 dB)	vs. Output voltage p-p	—	2-22	3-22	
Maximum p-p output voltage		vs Frequency	1-21	2-23	3-23	
Voltage noise density		vs Frequency	1-22	2-24	3-24	

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Main Characteristics (HA1630S01)

Figure 1-1. HA1630S01
Supply Current vs. Supply Voltage

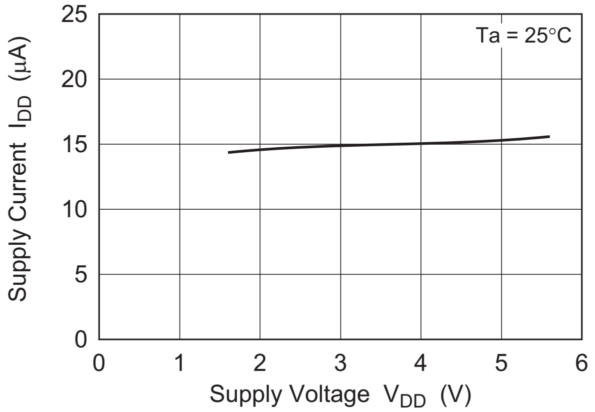

Figure 1-2. HA1630S01
Supply Current vs. Ambient Temperature

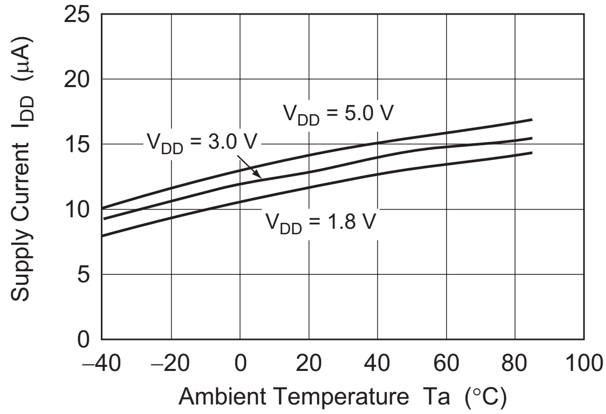

Figure 1-3. HA1630S01
Output High Voltage vs. Output Source Current

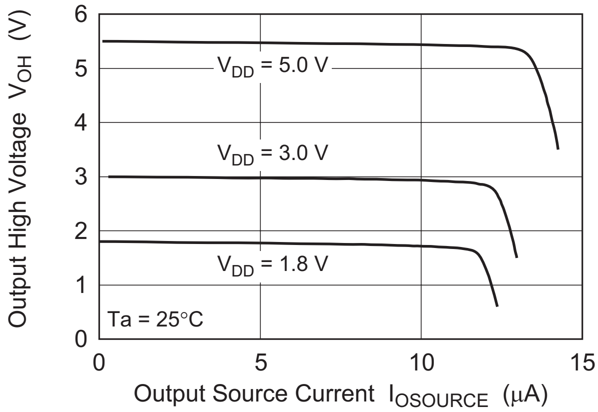

Figure 1-4. HA1630S01
Output High Voltage vs. Supply Voltage

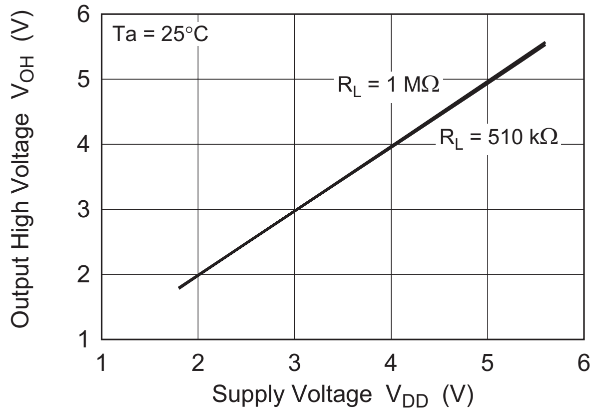

Figure 1-5. HA1630S01
Output Source Current vs. Ambient Temperature

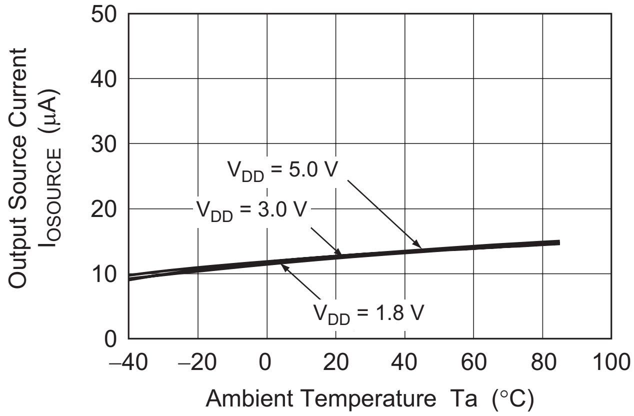

Figure 1-6. HA1630S01
Output Low Voltage vs. Output Sink Current

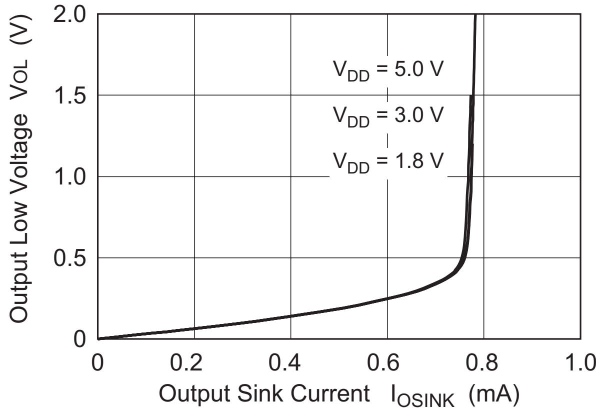

Figure 1-7. HA1630S01
Output Sink Current vs. Ambient Temperature

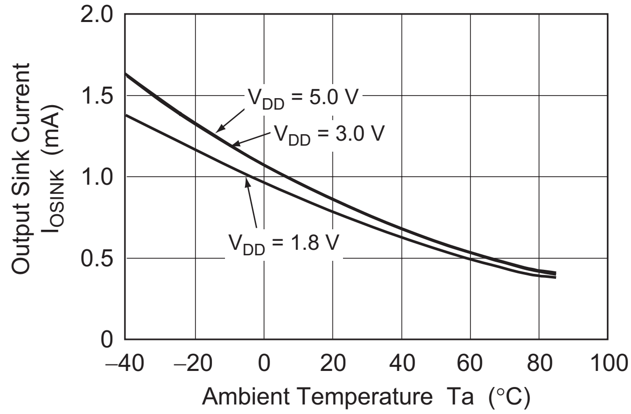

Figure 1-8. HA1630S01
Input Offset Voltage Distribution

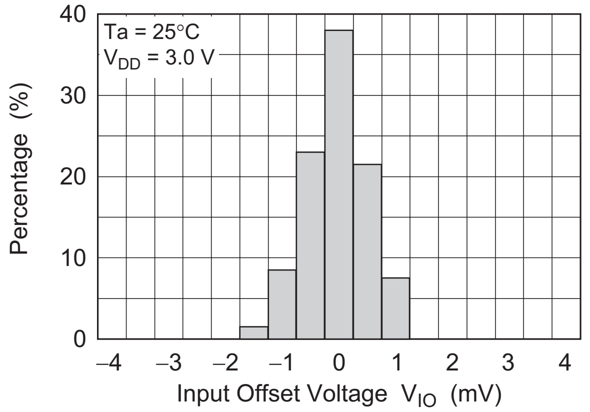

Figure 1-9. HA1630S01
Input Offset Voltage vs. Supply Voltage

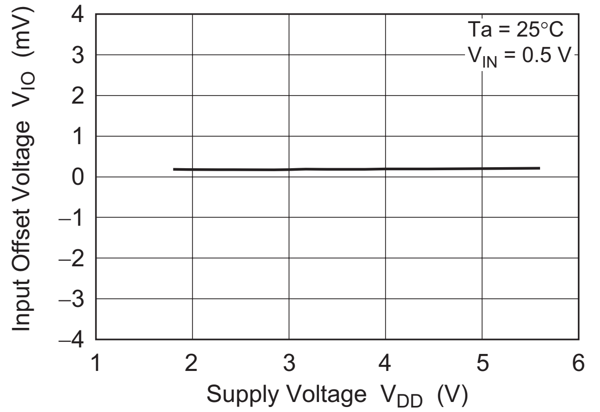

Figure 1-10. HA1630S01
Input Offset Voltage vs. Ambient Temperature

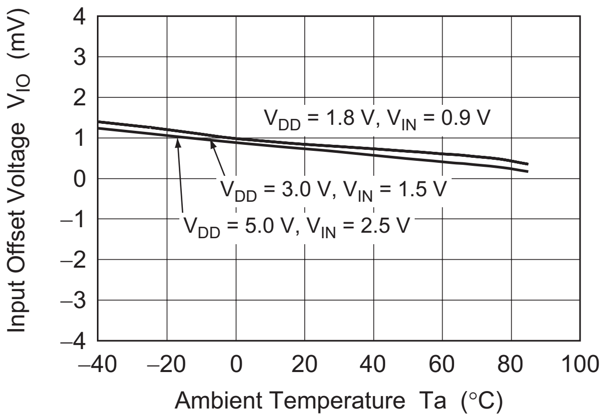

Figure 1-11. HA1630S01
Common Mode Input Voltage vs.
Ambient Temperature

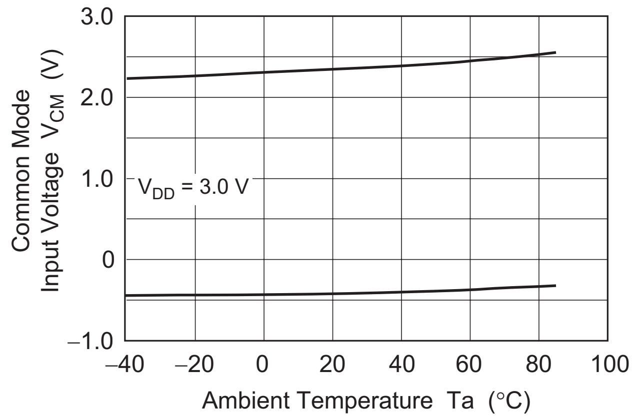

Figure 1-12. HA1630S01
Power Supply Rejection Ratio vs. Frequency

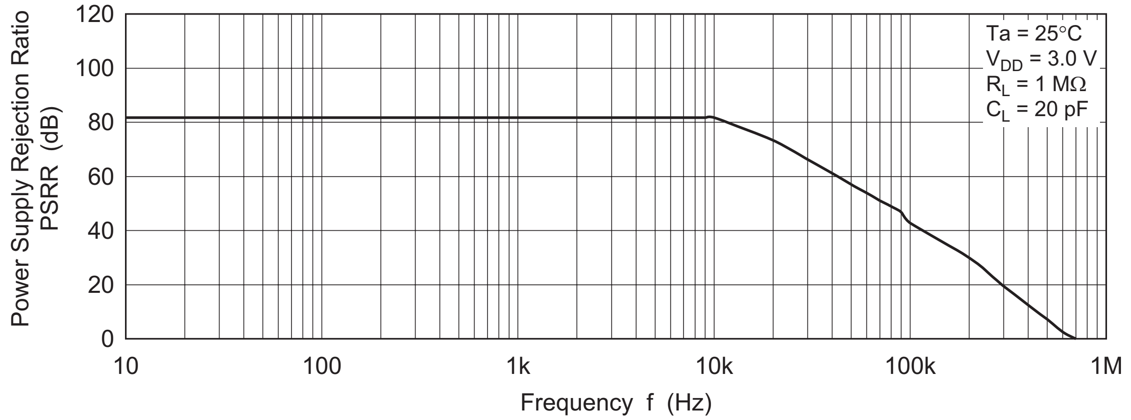

Figure 1-13. HA1630S01
Common Mode Rejection Ratio vs. Frequency

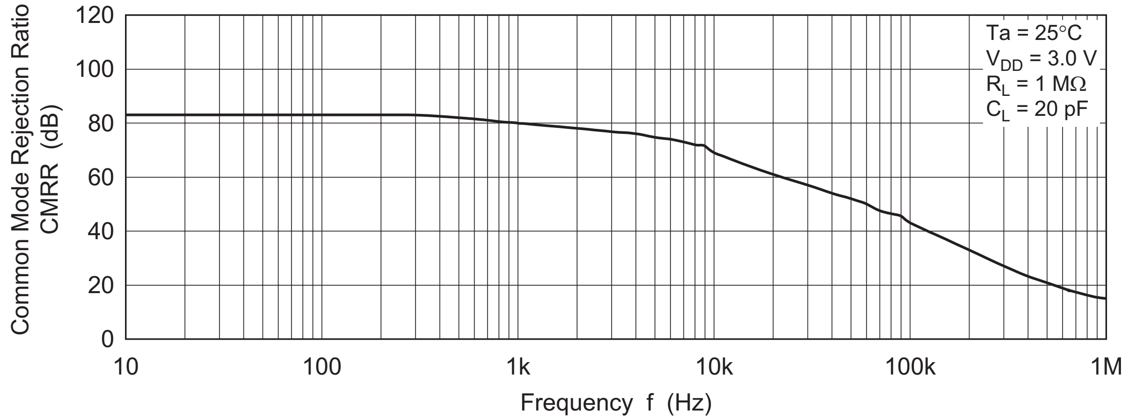

Figure 1-14. HA1630S01
Open Loop Voltage Gain and Phase Angle vs. Frequency

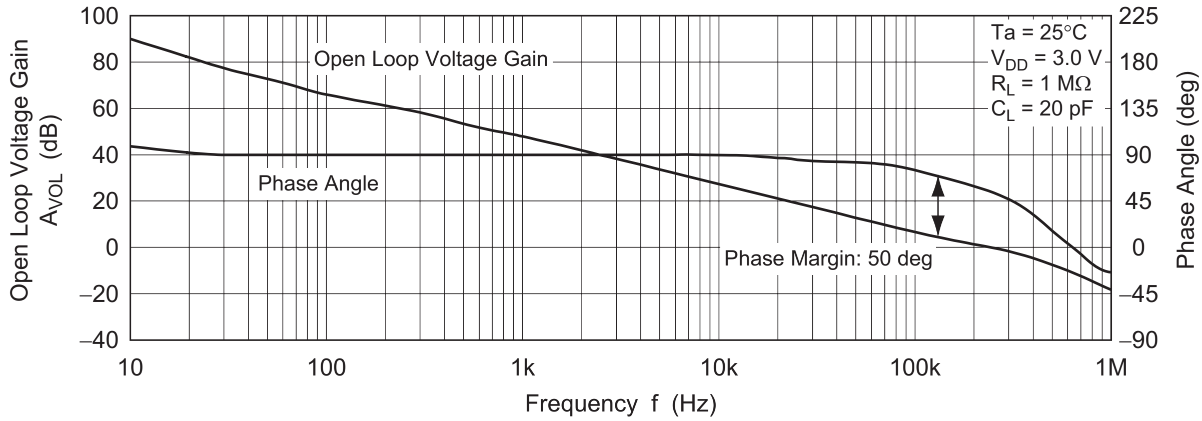

Figure 1-15. HA1630S01
Input Bias Current vs. Ambient Temperature

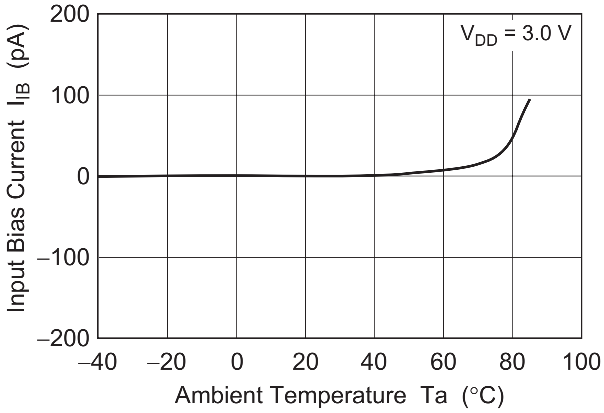

Figure 1-16. HA1630S01
Input Bias Current vs. Input Voltage

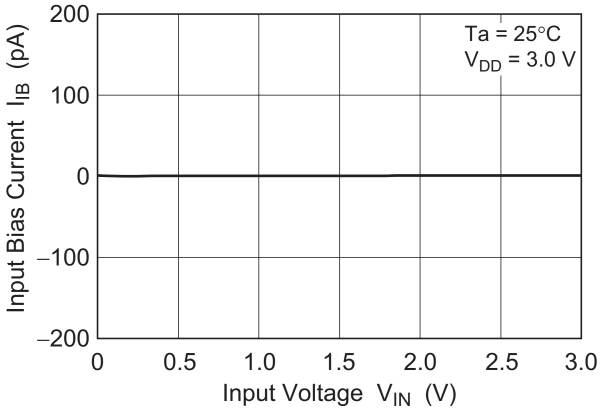

Figure 1-17. HA1630S01
Slew Rate (rising) vs. Ambient Temperature

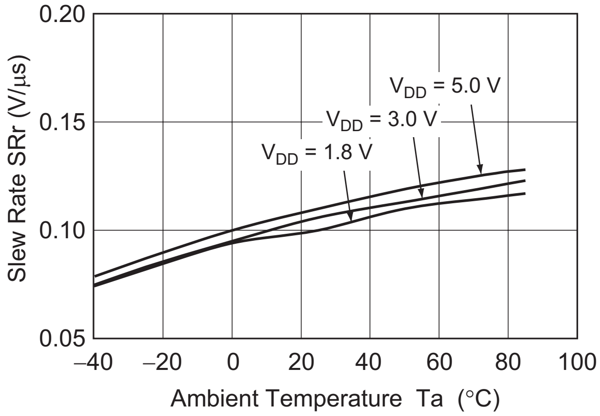

Figure 1-18. HA1630S01
Slew Rate (falling) vs. Ambient Temperature

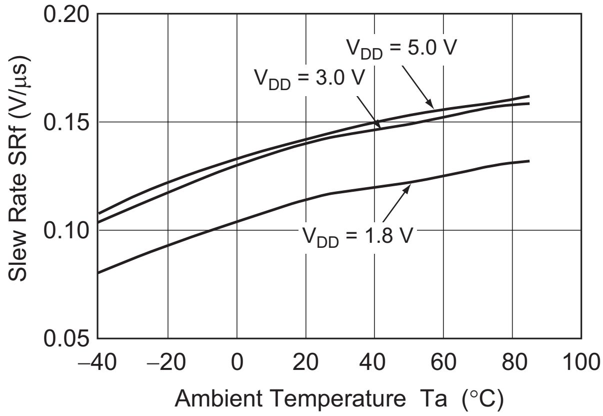

Figure 1-19. HA1630S01
Large Signal Transient Response

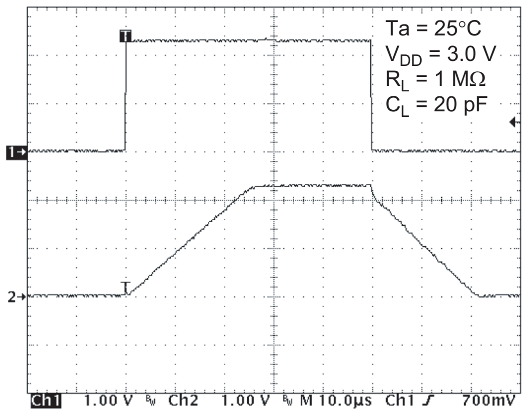

Figure 1-20. HA1630S01
Small Signal Transient Response

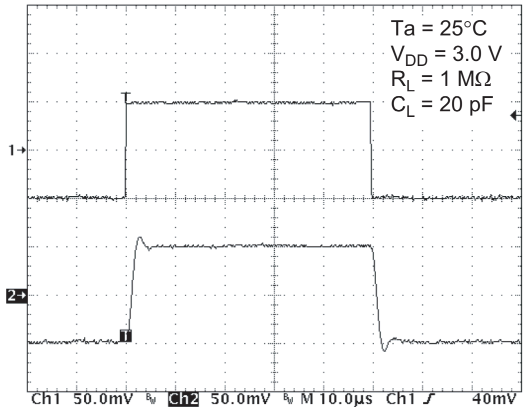

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Figure 1-21. HA1630S01
Voltage Output p-p vs. Frequency

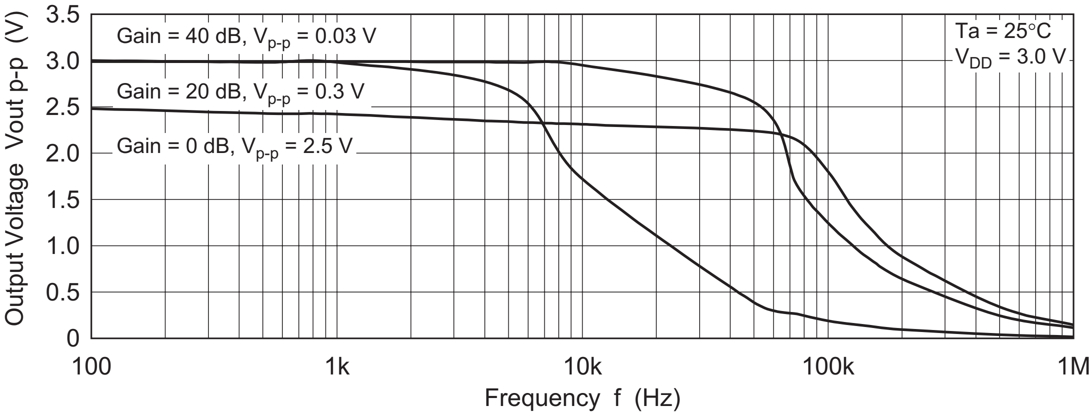
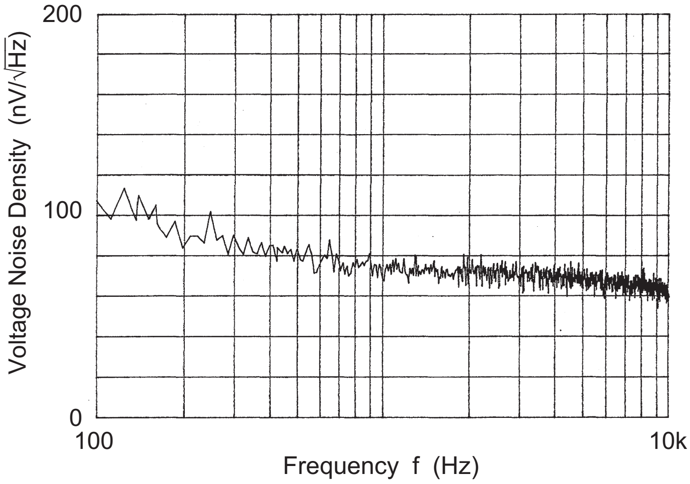


Figure 1-22. HA1630S01
Voltage Noise Density vs. Frequency



Main Characteristics (HA1630S02)

Figure 2-1. HA1630S02
Supply Current vs. Supply Voltage

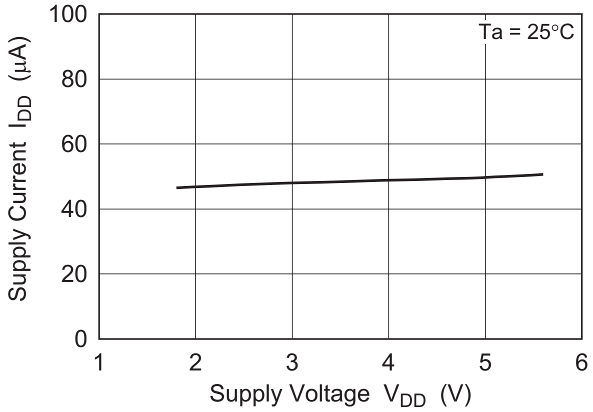


Figure 2-2. HA1630S02
Supply Current vs. Ambient Temperature

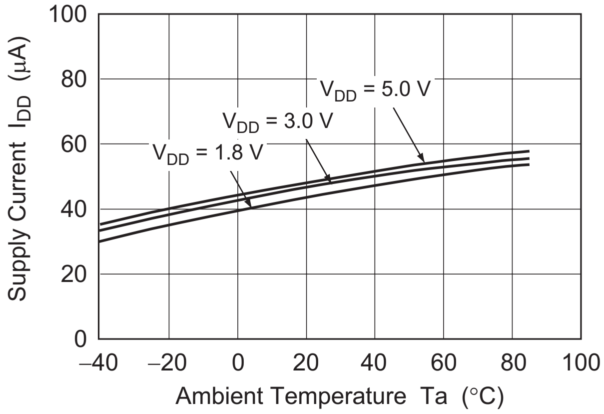


Figure 2-3. HA1630S02
Output High Voltage vs. Output Source Current

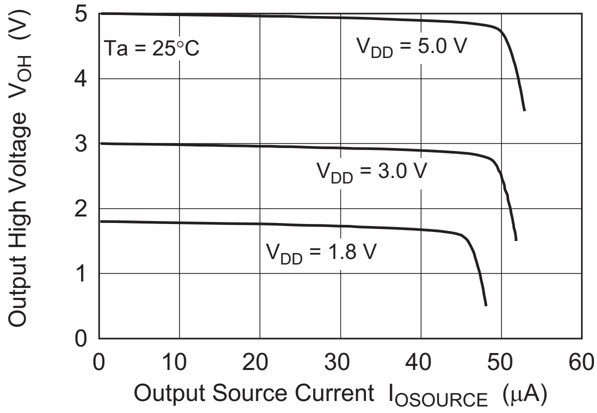


Figure 2-4. HA1630S02
Output High Voltage vs. Supply Voltage

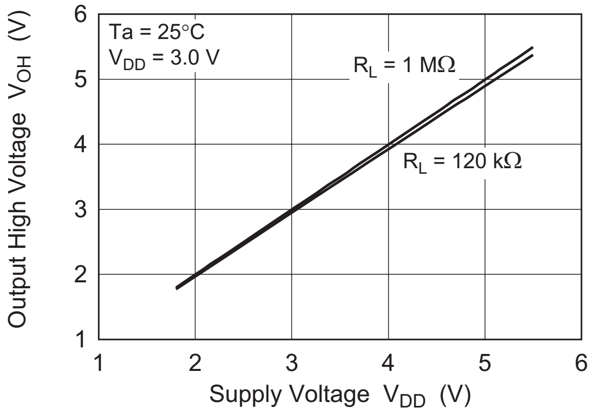


Figure 2-5. HA1630S02
Output Source Current vs. Ambient Temperature

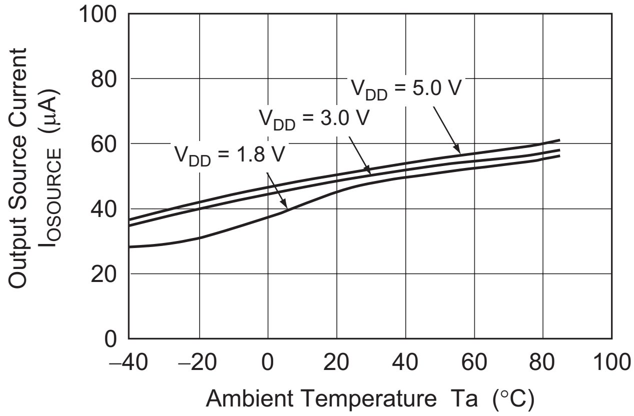


Figure 2-6. HA1630S02
Output Low Voltage vs. Output Sink Current

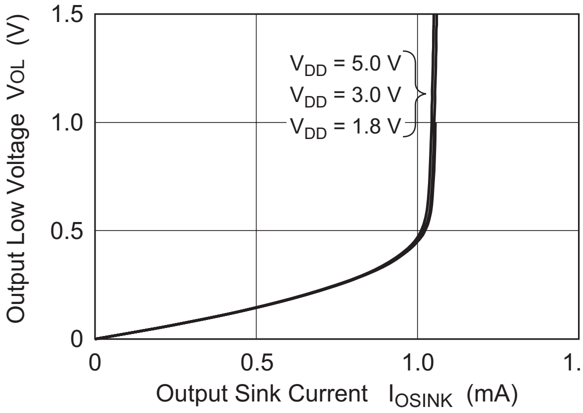


Figure 2-7. HA1630S02
Output Sink Current vs. Ambient Temperature

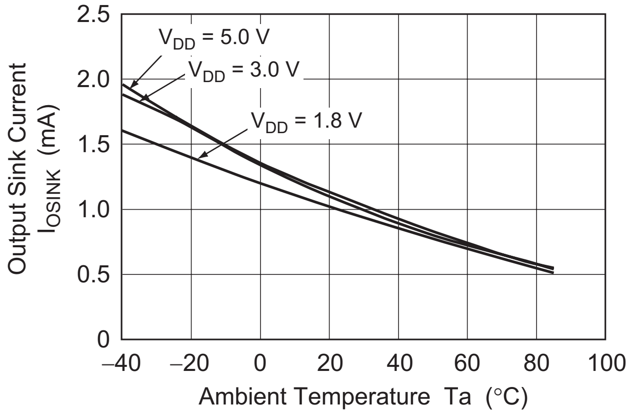


Figure 2-8. HA1630S02
Input Offset Voltage Distribution

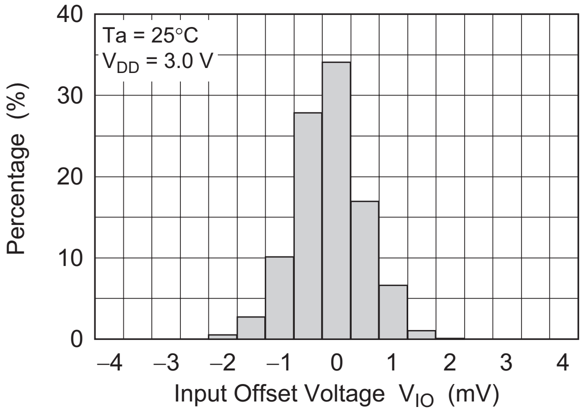


Figure 2-9. HA1630S02
Input Offset Voltage vs. Supply Voltage

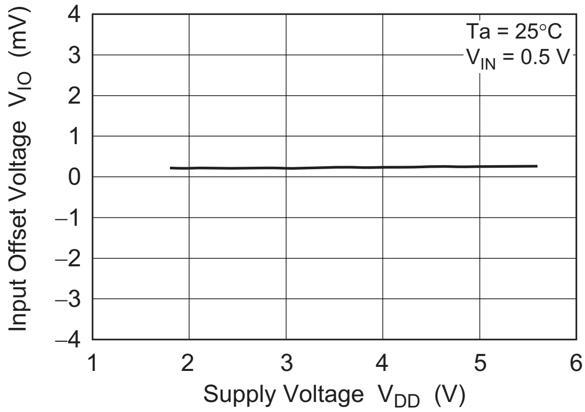


Figure 2-10. HA1630S02
Input Offset Voltage vs. Ambient Temperature

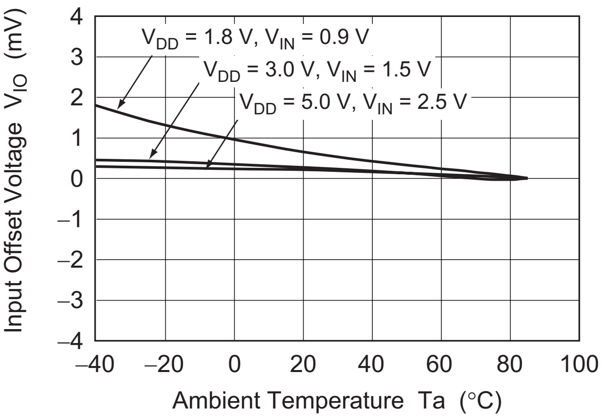


Figure 2-11. HA1630S02
Common Mode Input Voltage vs.
Ambient Temperature

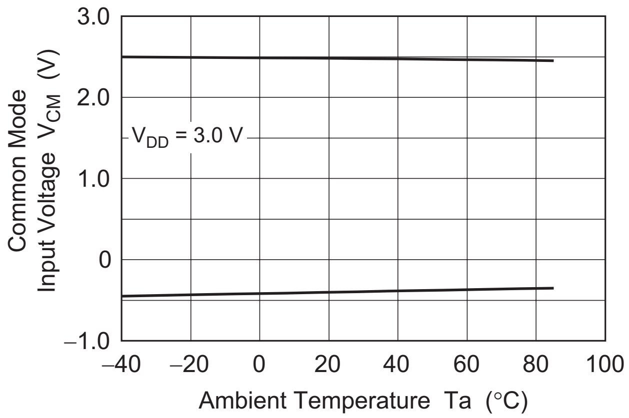


Figure 2-12. HA1630S02
Power Supply Rejection Ratio vs. Frequency

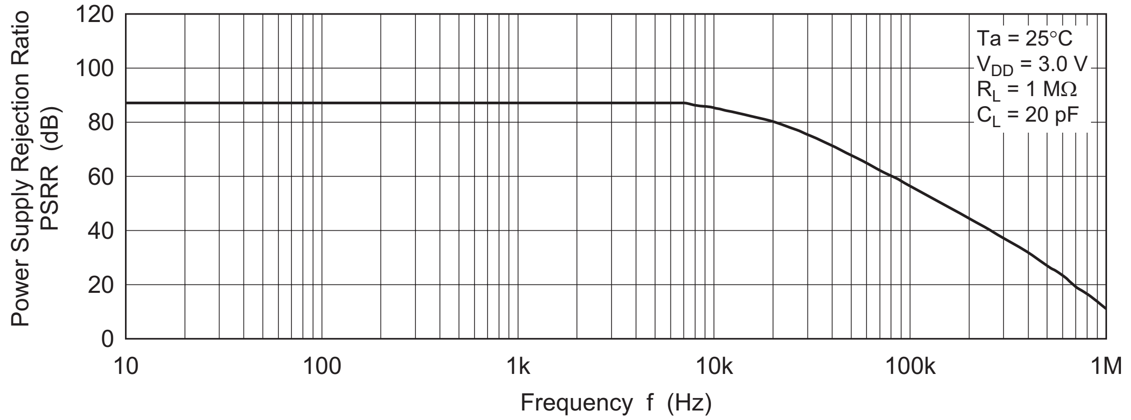


Figure 2-13. HA1630S02
Common Mode Rejection Ratio vs. Frequency

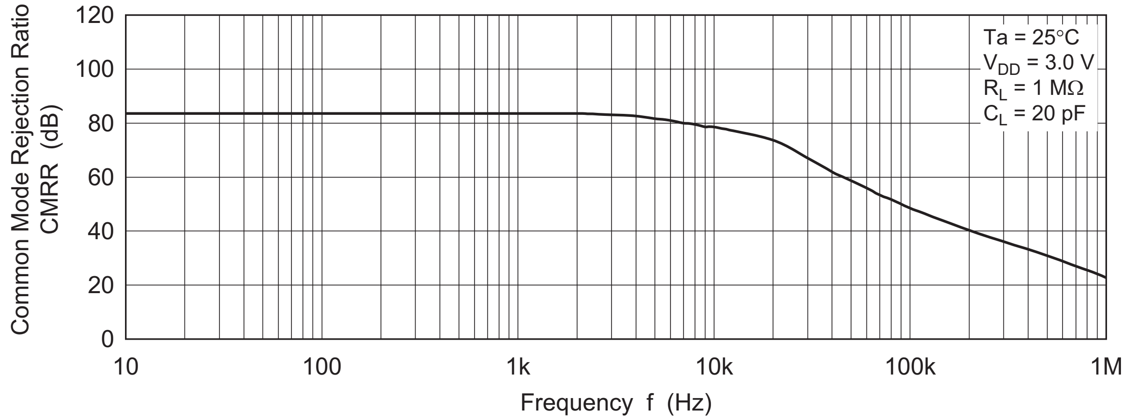


Figure 2-14. HA1630S02
Open Loop Voltage Gain and Phase Angle vs. Frequency

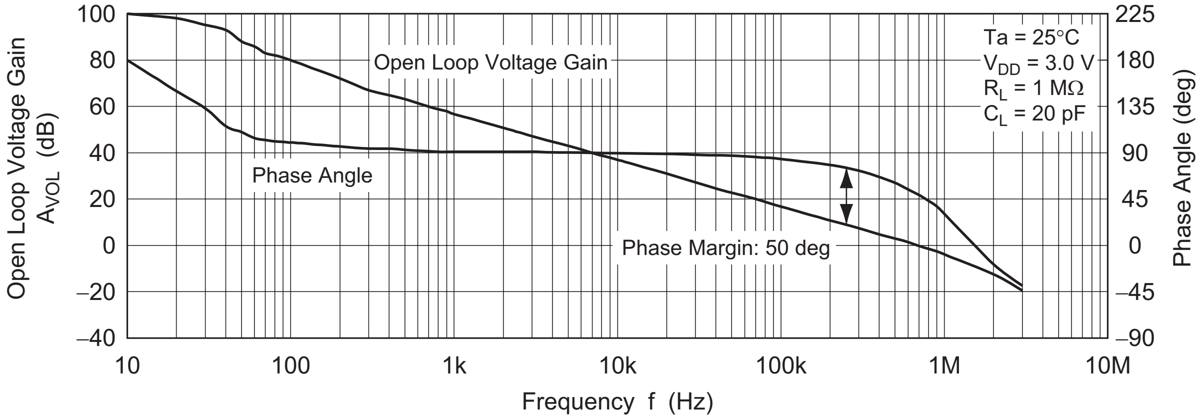


Figure 2-15. HA1630S02
Input Bias Current vs. Ambient Temperature

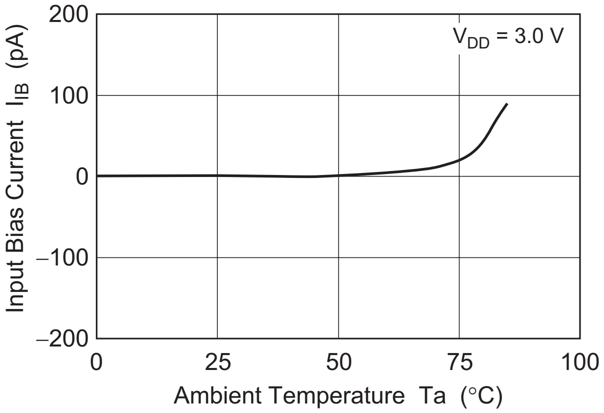


Figure 2-16. HA1630S02
Input Bias Current vs. Input Voltage

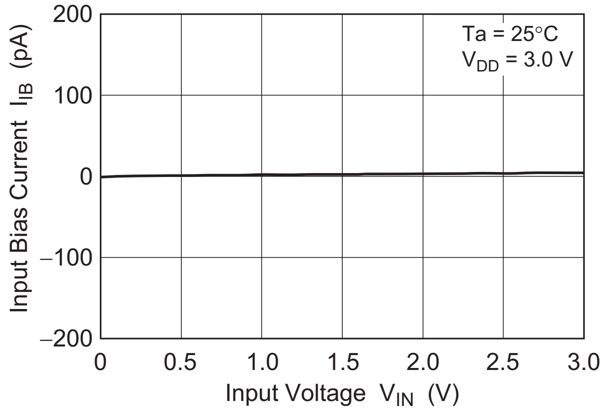


Figure 2-17. HA1630S02
Slew Rate (rising) vs. Ambient Temperature

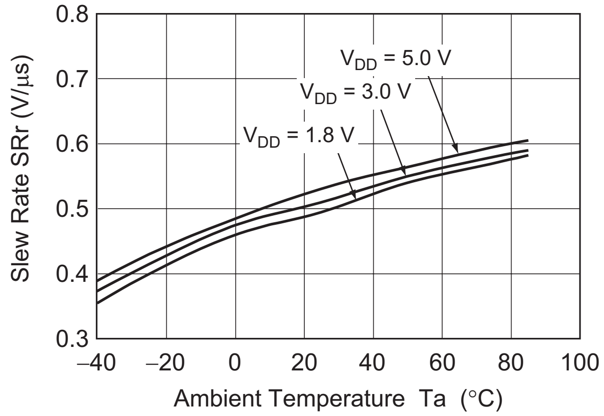


Figure 2-18. HA1630S02
Slew Rate (falling) vs. Ambient Temperature

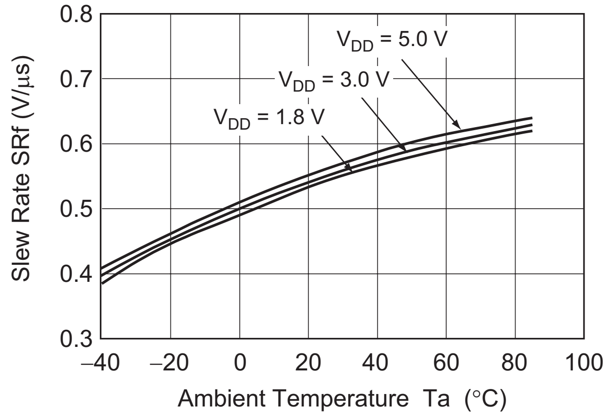


Figure 2-19. HA1630S02
Large Signal Transient Response

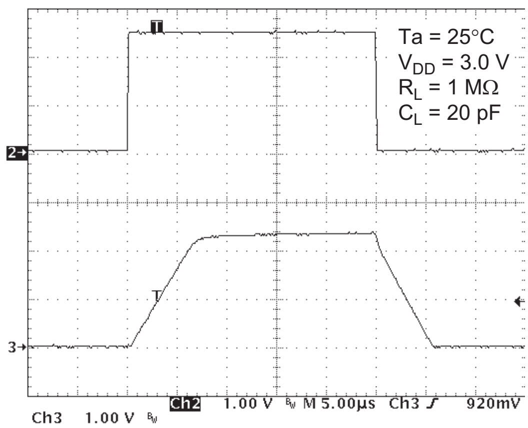


Figure 2-20. HA1630S02
Small Signal Transient Response

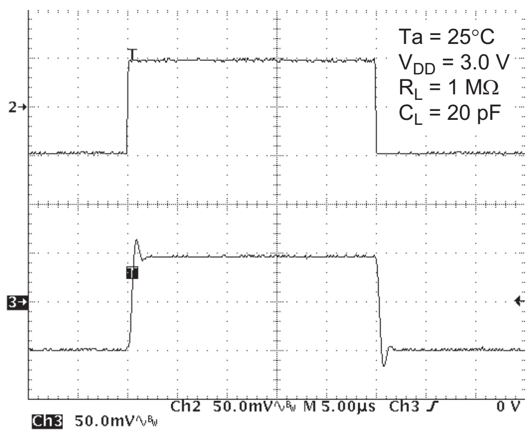


Figure 2-21. HA1630S02
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

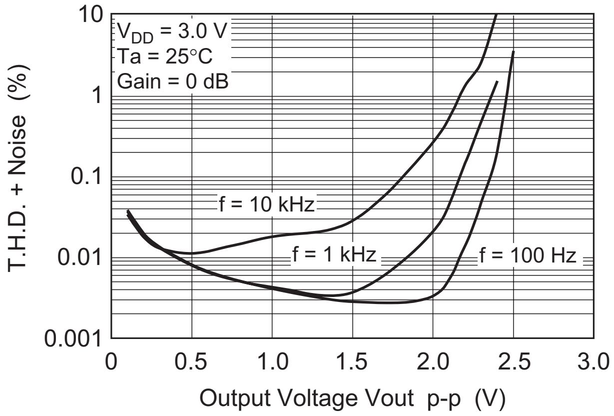


Figure 2-22. HA1630S02
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

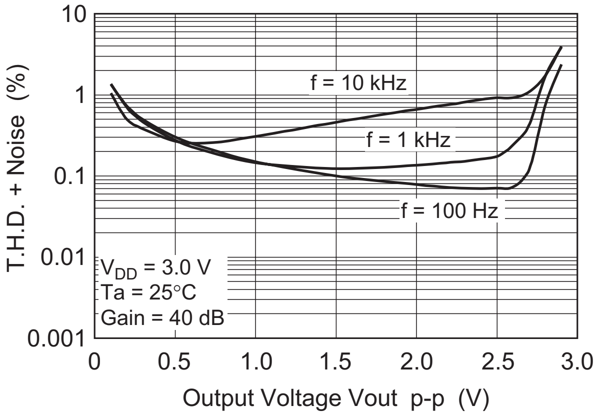


Figure 2-23. HA1630S02
Voltage Output p-p vs. Frequency

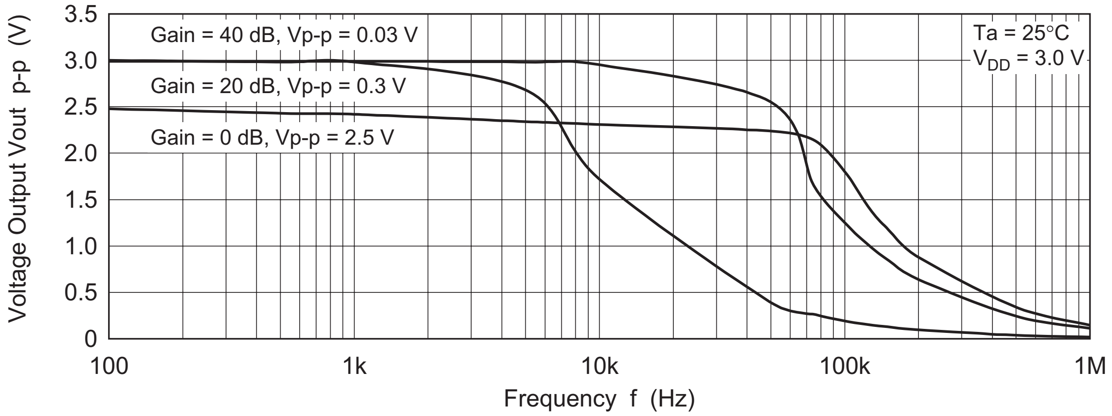
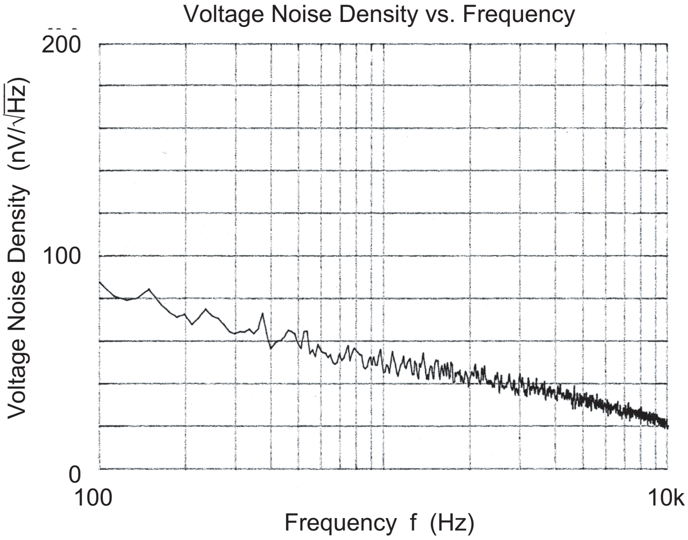


Figure 2-24. HA1630S02
Voltage Noise Density vs. Frequency



RENESAS

Main Characteristics (HA1630S03)

Figure 3-1. HA1630S03
Supply Current vs. Supply Voltage

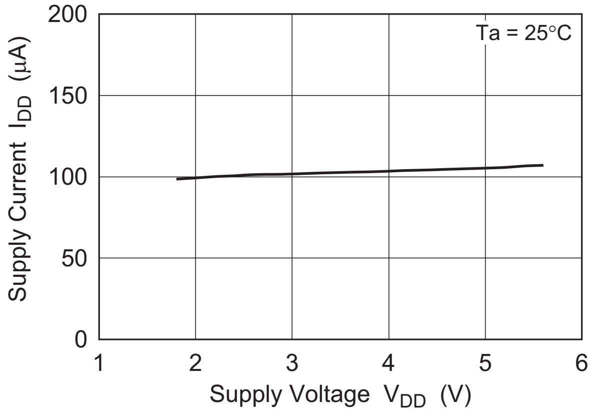


Figure 3-2. HA1630S03
Supply Current vs. Ambient Temperature

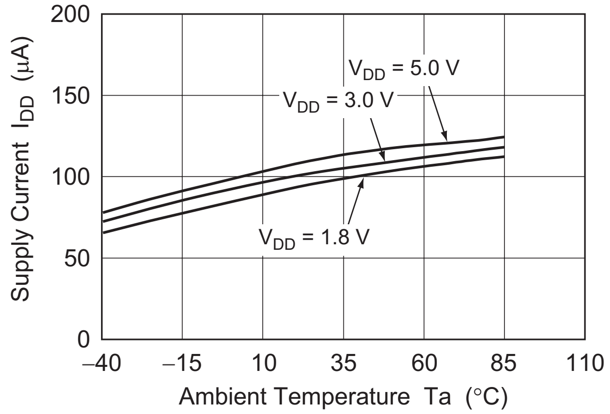


Figure 3-3. HA1630S03
Output High Voltage vs. Output Source Current

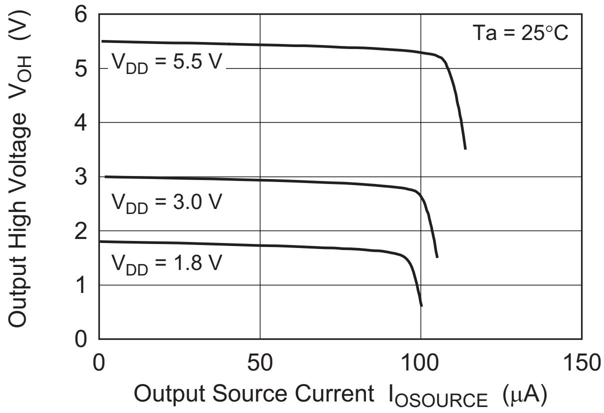


Figure 3-4. HA1630S03
Output High Voltage vs. Supply Voltage

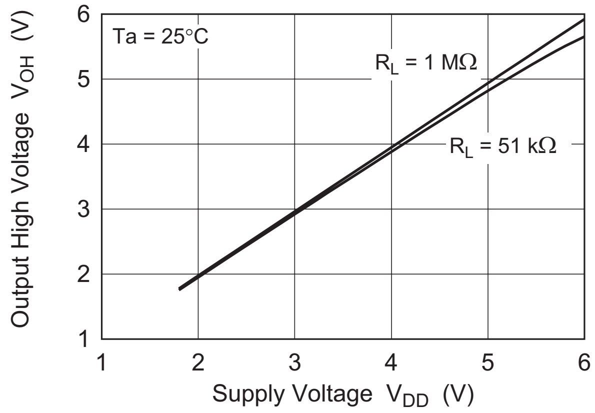


Figure 3-5. HA1630S03
Output Source Current vs. Ambient Temperature

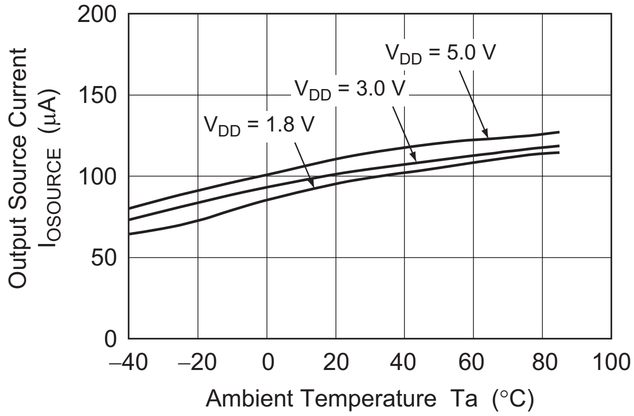


Figure 3-6. HA1630S03
Output Low Voltage vs. Output Sink Current

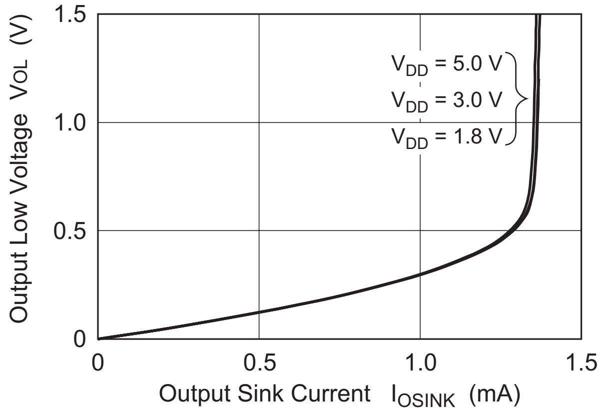


Figure 3-7. HA1630S03
Output Sink Current vs. Ambient Temperature

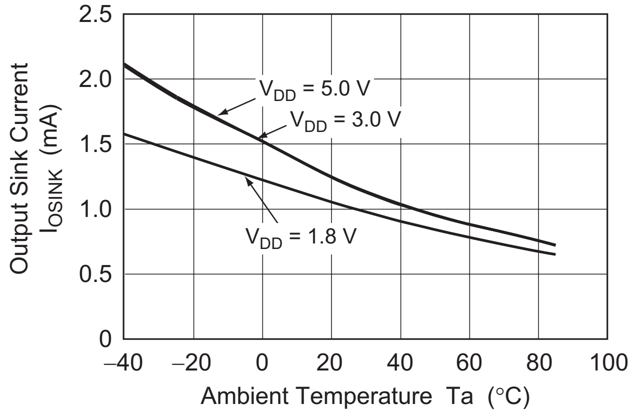


Figure 3-8. HA1630S03
Input Offset Voltage Distribution

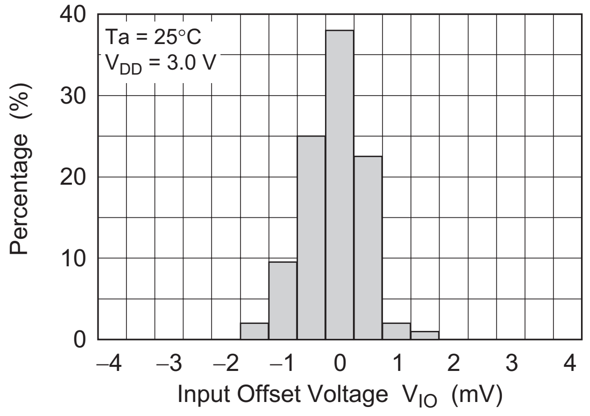


Figure 3-9. HA1630S03
Input Offset Voltage vs. Supply Voltage

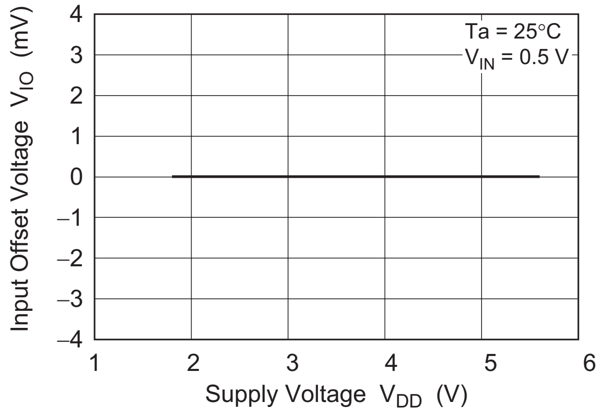


Figure 3-10. HA1630S03
Input Offset Voltage vs. Ambient Temperature

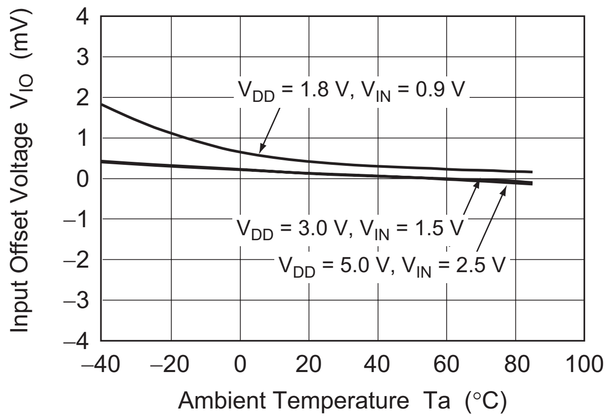


Figure 3-11. HA1630S03
Common Mode Input Voltage vs.
Ambient Temperature

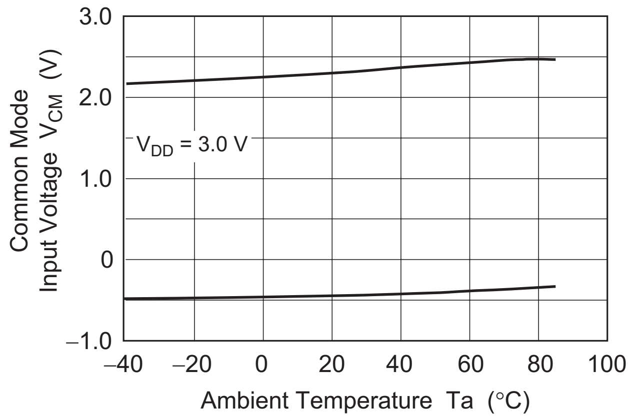


Figure 3-12. HA1630S03
Power Supply Rejection Ratio vs. Frequency

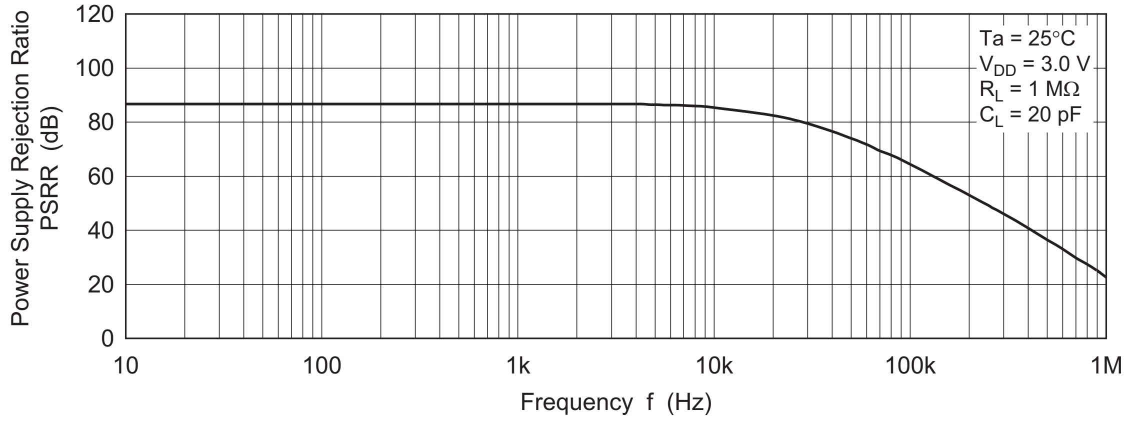


Figure 3-13. HA1630S03
Common Mode Rejection Ratio vs. Frequency

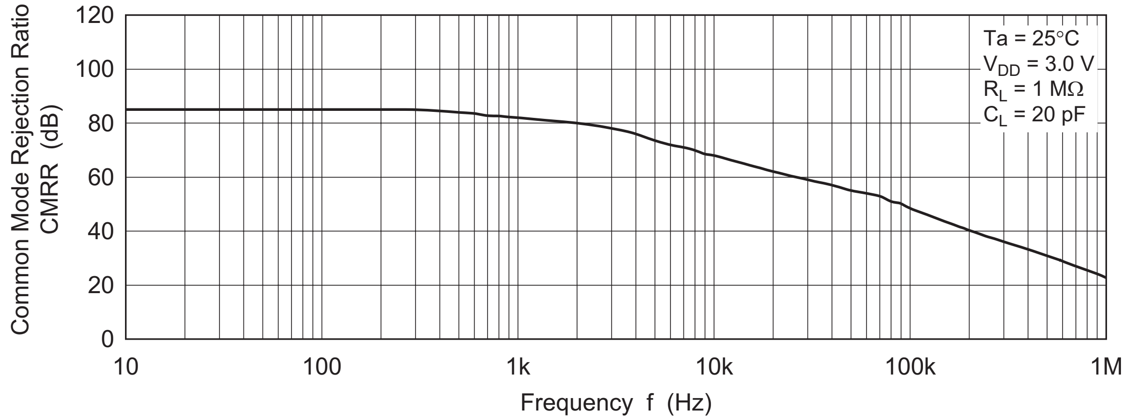


Figure 3-14. HA1630S03
Open Loop Voltage Gain and Phase Angle vs. Frequency

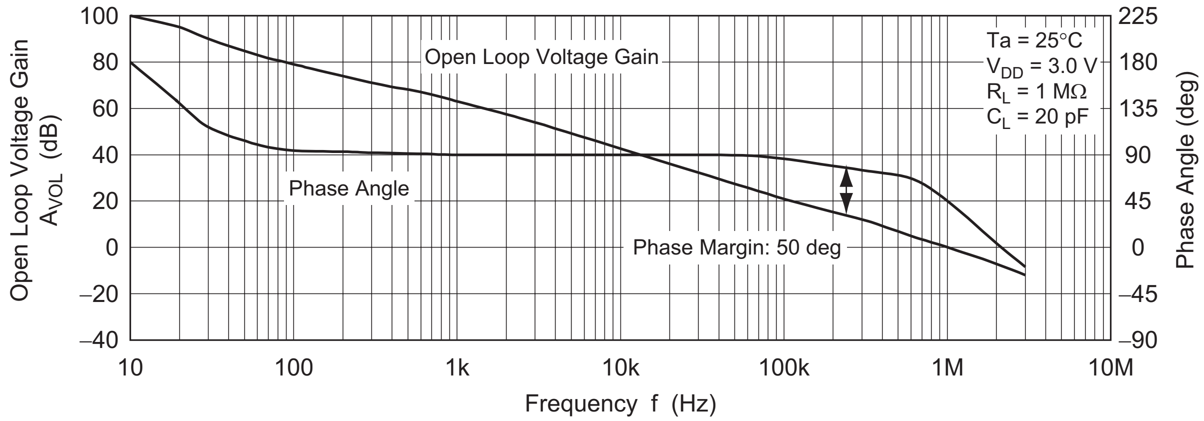


Figure 3-15. HA1630S03
Input Bias Current vs. Ambient Temperature

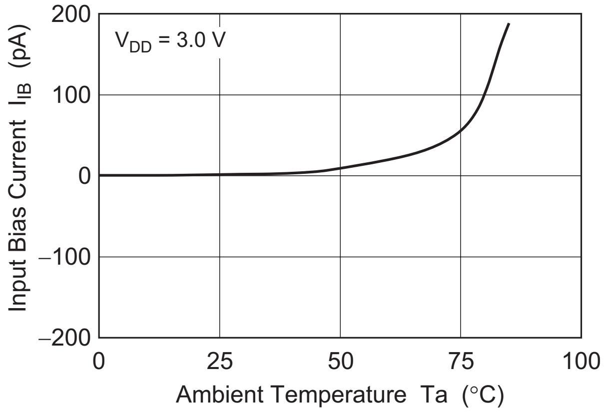


Figure 3-16. HA1630S03
Input Bias Current vs. Input Voltage

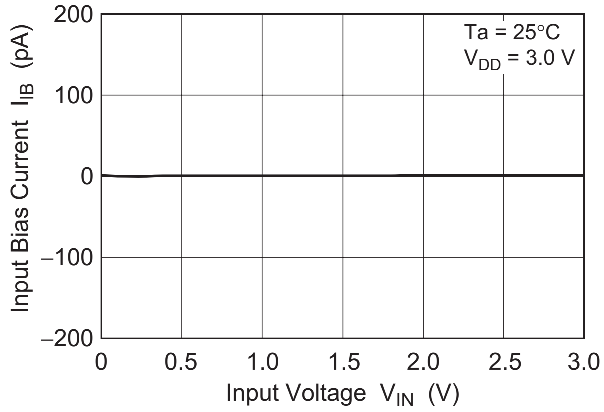


Figure 3-17. HA1630S03
Slew Rate (rising) vs. Ambient Temperature

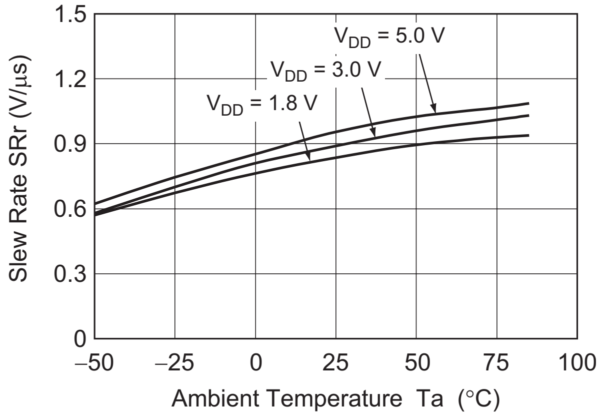


Figure 3-18. HA1630S03
Slew Rate (falling) vs. Ambient Temperature

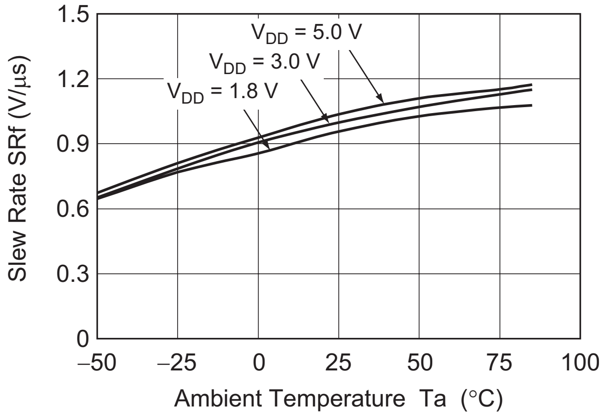


Figure 3-19. HA1630S03
Large Signal Transient Response

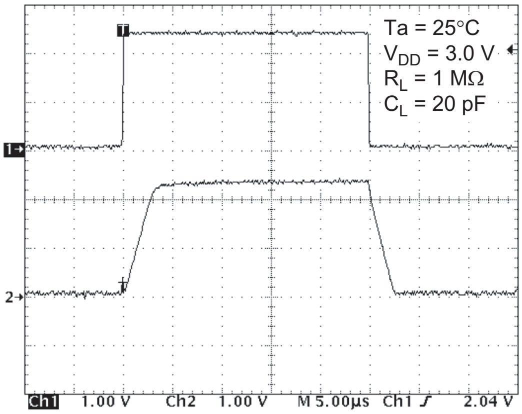


Figure 3-20. HA1630S03
Small Signal Transient Response

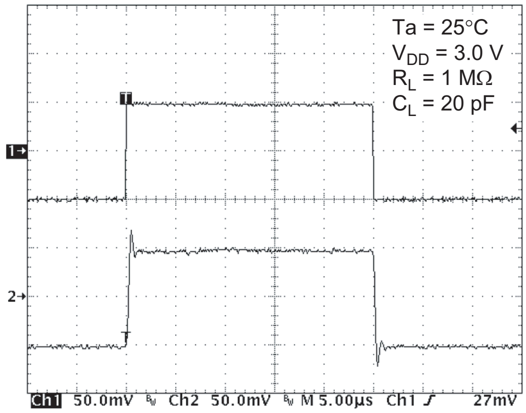


Figure 3-21. HA1630S03
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

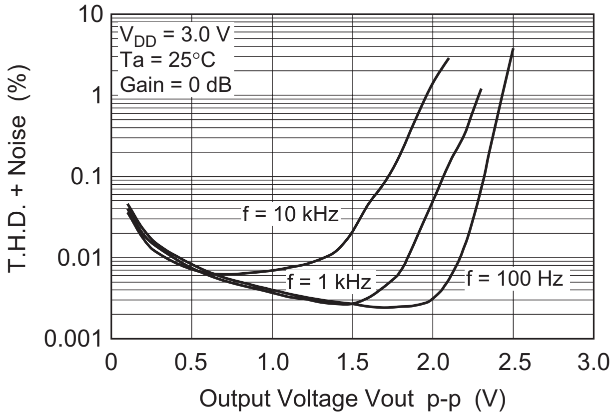


Figure 3-22. HA1630S03
Total Harmonic Distortion + Noise vs.
Output Voltage p-p

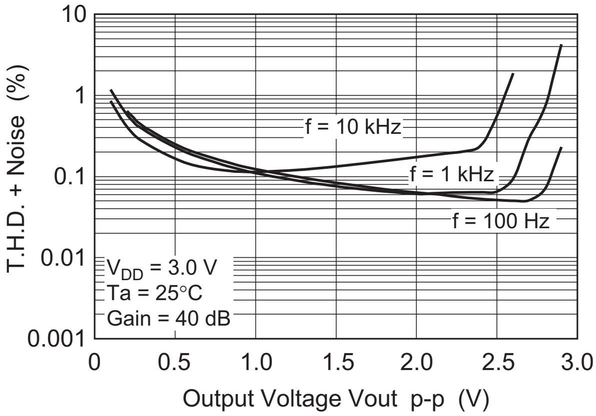


Figure 3-23. HA1630S03
Voltage Output p-p vs. Frequency

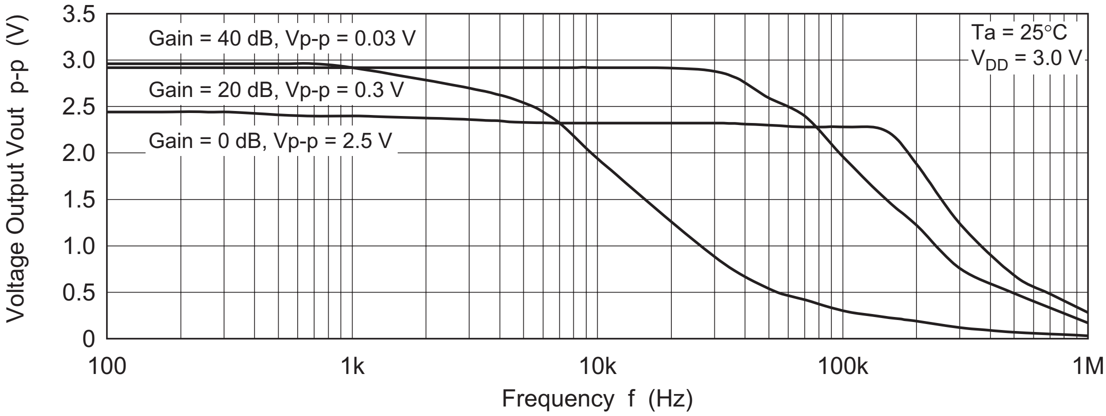
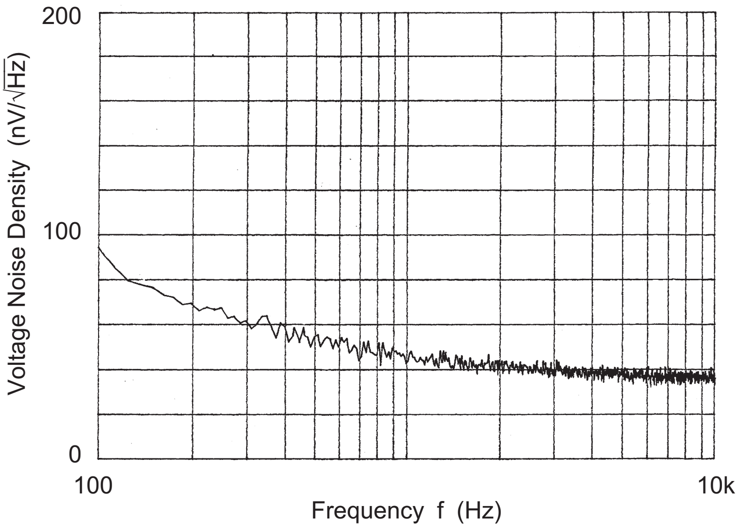
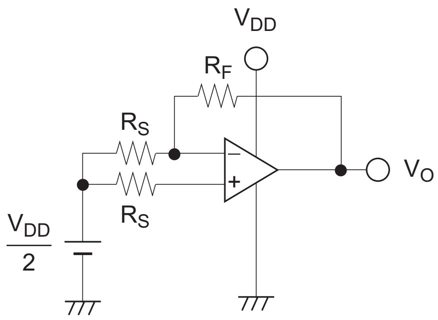


Figure 3-24. HA1630S03
Voltage Noise Density vs. Frequency



Test Circuits

1. Power Supply Rejection Ratio, PSRP & Voltage Offset, V_{IO}



V_{IO}

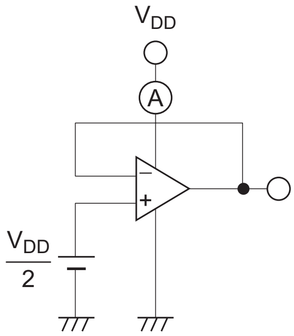
$$V_{IO} = \left(V_O - \frac{V_{DD}}{2}\right) \times \frac{R_S}{R_S + R_F}$$

PSRR

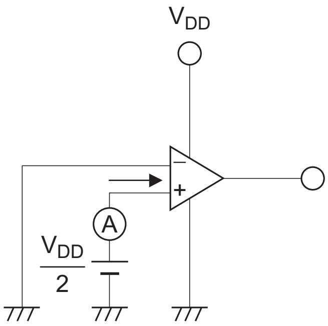
$$PSRR = -20\log\left(\left|\frac{V_{O1} - V_{O2}}{V_{DD1} - V_{DD2}}\right| \times \frac{R_S}{R_S + R_F}\right)$$

Measure V_O corresponding to V_{DD1} = 1.8 V and V_{DD2} = 5.5 V

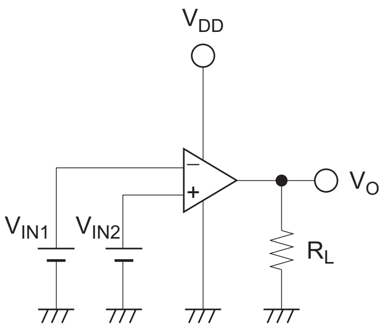
2. Supply Current, I_{DD}



3. Input Bias Current, I_{IB}



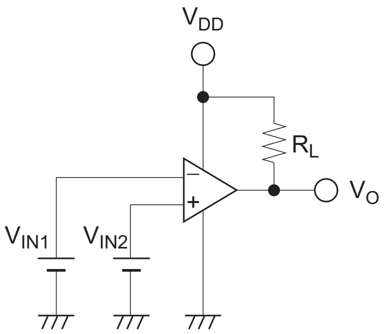
4. Output High Voltage, V_{OH}



V_{OH}

R_L = 1 MΩ
$V_{IN1} = V_{DD} / 2 - 0.05$ V
$V_{IN2} = V_{DD} / 2 + 0.05$ V

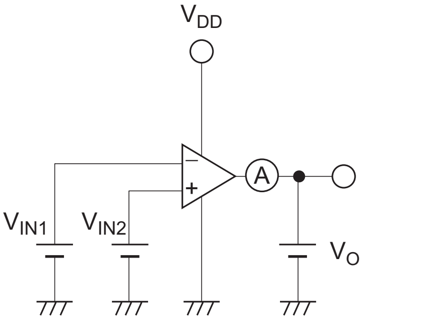
5. Output Low Voltage, V_{OL}



V_{OL}

R_L = 1 MΩ
$V_{IN1} = V_{DD} / 2 + 0.05$ V
$V_{IN2} = V_{DD} / 2 - 0.05$ V

6. Output Source Current, $I_{OSOURCE}$ & Output Sink Current, I_{OSINK}



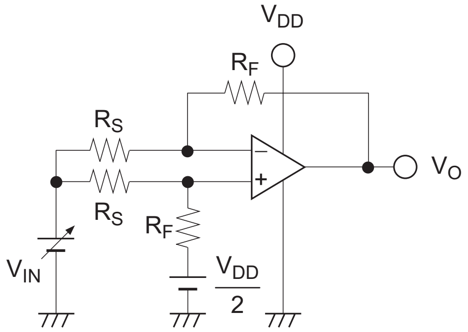
$\underline{I_{OSOURCE}}$

$V_O = V_{DD} - 0.5\ V$
$V_{IN1} = V_{DD} / 2 - 0.05\ V$
$V_{IN2} = V_{DD} / 2 + 0.05\ V$

$\underline{I_{OSINK}}$

$V_O = +0.5\ V$
$V_{IN1} = V_{DD} / 2 + 0.05\ V$
$V_{IN2} = V_{DD} / 2 - 0.05\ V$

7. Common Mode Input Voltage, V_{CM} & Common Mode Rejection Ratio, CMRR

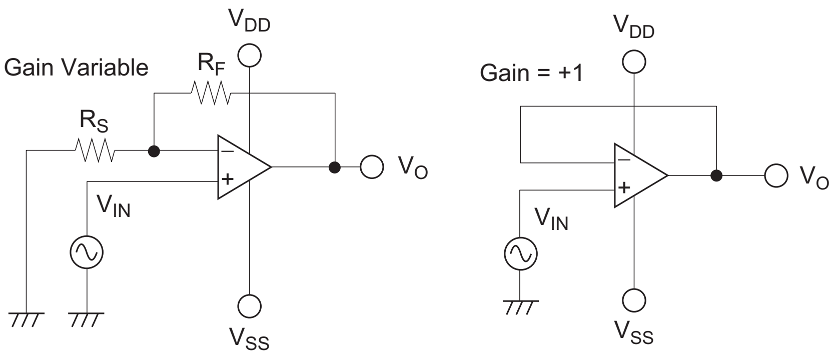


CMRR

$$CMRR = -20\log\left(\left|\frac{V_{O1} - V_{O2}}{V_{IN1} - V_{IN2}}\right| \times \frac{R_S}{R_S + R_F}\right)$$

Measure V_O corresponding to $V_{IN1} = 0\ V$ and $V_{IN2} = 2.1\ V$

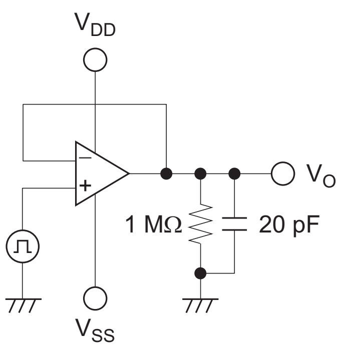
8. Total Harmonic Distortion, THD



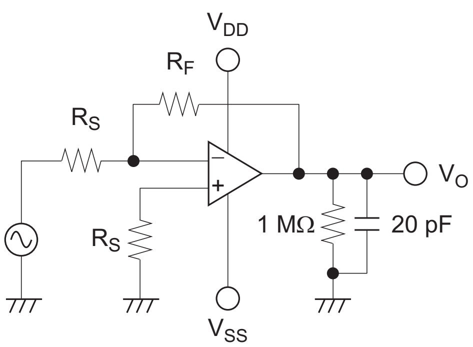
THD

Gain Variable
$1 + R_F / R_S = 100$
freq = 100 Hz, 1 kHz, 10 kHz

9. Slew Rate, SR



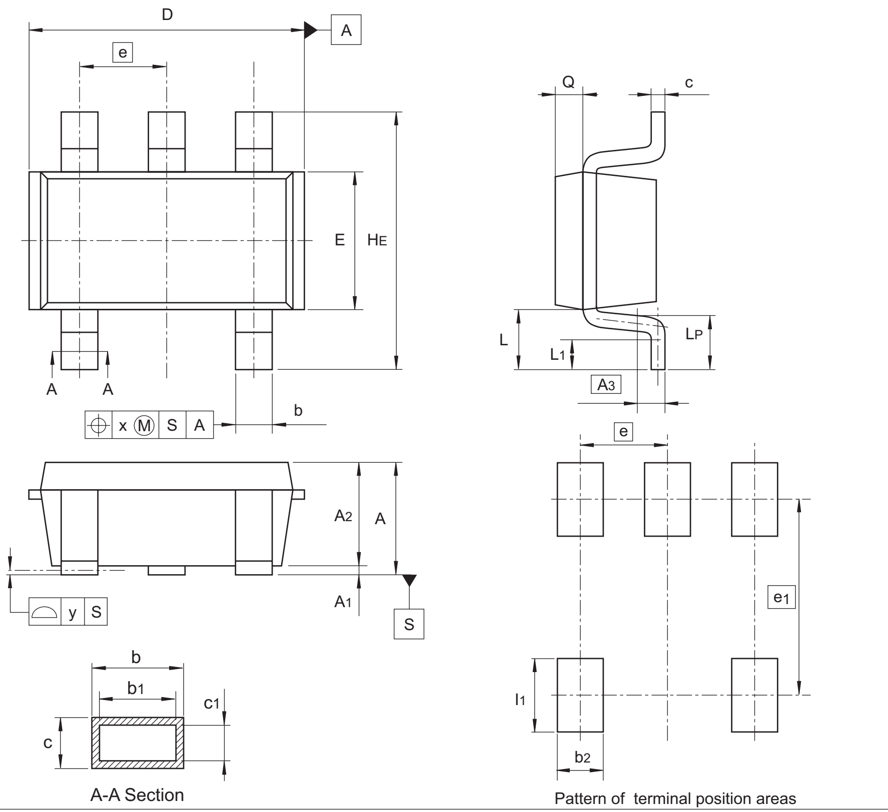
10. Gain, A_V & Phase, GBW



RENESAS

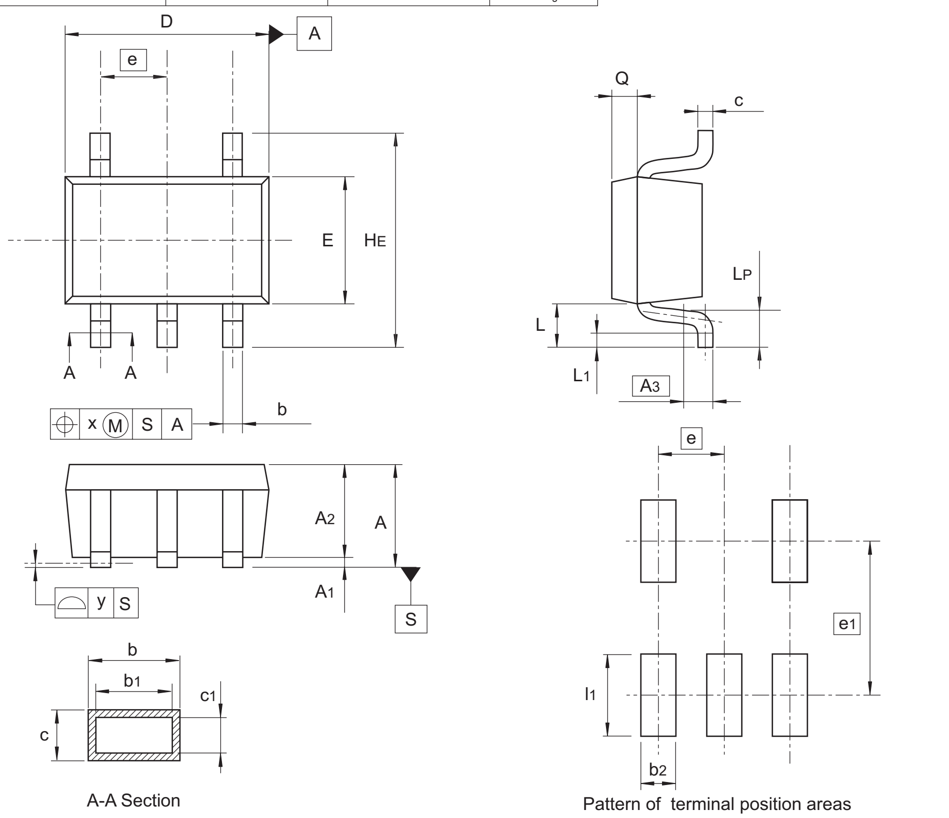
Package Dimensions

Package Name	JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
MPAK-5	SC-74A	PLSP0005ZB-A	MPAK-5 / MPAK-5V	0.015g



Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	1.0	–	1.3
A_1	0	–	0.1
A_2	1.0	1.1	1.2
A_3	–	0.25	–
b	0.35	0.42	0.5
b_1	–	0.4	–
c	0.1	0.13	0.15
c_1	–	0.11	–
D	2.8	2.95	3.1
E	1.5	1.6	1.8
e	–	0.95	–
H_E	2.5	2.8	3.0
L	0.3	–	0.7
L_1	0.1	–	0.5
L_P	0.2	–	0.6
x	–	–	0.05
y	–	–	0.05
b_2	–	–	0.55
e_1	–	2.15	–
l_1	–	–	0.85
Q	–	0.3	–

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
SC-88A	PTSP0005ZC-A	CMPAK-5 / CMPAK-5V	0.006g

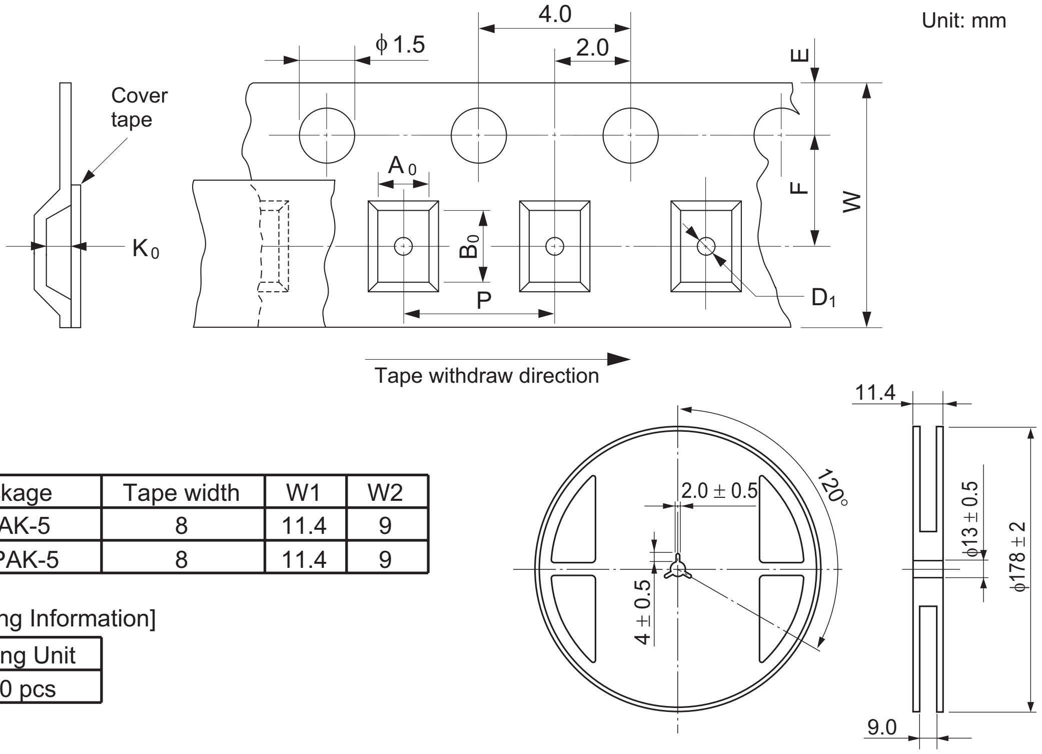


Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	0.8	–	1.1
A_1	0	–	0.1
A_2	0.8	0.9	1.0
A_3	–	0.25	–
b	0.15	0.22	0.3
b_1	–	0.2	–
c	0.1	0.13	0.15
c_1	–	0.11	–
D	1.8	2.0	2.2
E	1.15	1.25	1.35
e	–	0.65	–
H_E	1.8	2.1	2.4
L	0.3	–	0.7
L_1	0.1	–	0.5
L_P	0.2	–	0.6
x	–	–	0.05
y	–	–	0.05
b_2	–	–	0.35
e_1	–	1.5	–
l_1	–	–	0.9
Q	–	0.25	–

Taping & Reel Specification

[Taping]

Package Code	W	P	Ao	Bo	Ko	E	F	D1	Maximum Storage No.
MPAK-5	8	4	3.3	3.3	1.5	1.75	3.5	1.05	3,000 pcs/reel
CMPAK-5	8	4	2.25	2.45	1.1	1.75	3.5	1.05	3,000 pcs/reel



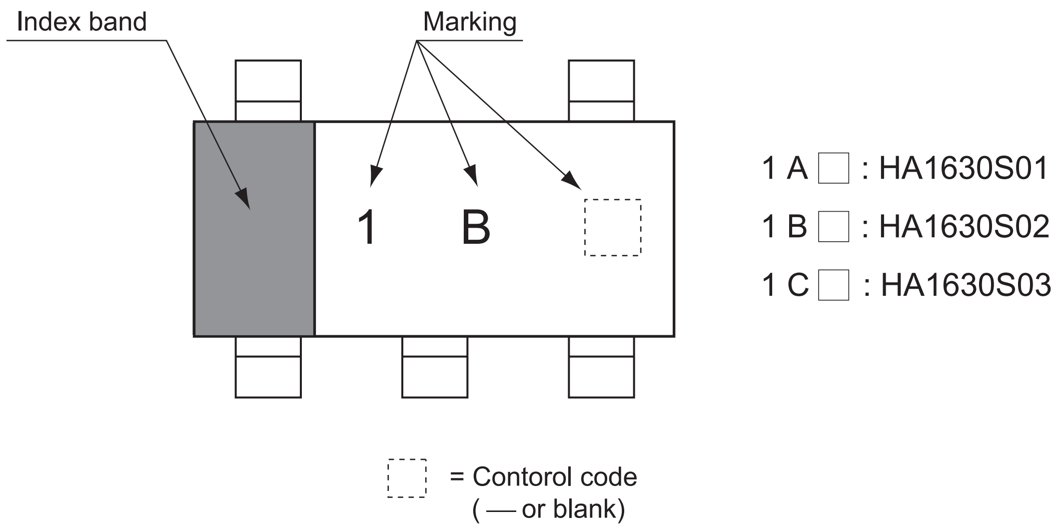
[Reel]

Package	Tape width	W1	W2
MPAK-5	8	11.4	9
CMPAK-5	8	11.4	9

[Ordering Information]

Ordering Unit
3,000 pcs

Mark Indication



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Colophon .6.0